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2007

InfoTips on mangrove-friendly shrimp farming

Aquaculture Department, Southeast Asian Fisheries Development Center

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InfoTips



on Mangrove-friendly shrimp farming



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In the 80s, shrimp farming was lucrative business until it slumped in the 90s due to the outbreak of diseases brought about by intensified production. Moreover, the rapid expansion of fishpond development is said to be the main cause of the destruction of the region's mangrove forests. Shrimp pond effluents, emptied directly into the surrounding coastal waters, contributed to the deterioration of the environment that eventually affected fisheries and aquaculture itself.

Realizing the importance of the shrimp industry's contribution to the economy of Southeast Asian countries, SEAFDEC through the ASEAN-SEAFDEC Fisheries Consultative Group mechanism implemented the Mangrove-Friendly Shrimp Culture Project in 2000 with funding from the Fisheries Agency of the Government of Japan. This project aimed to develop sustainable culture technology packages on shrimp farming that are friendly to mangroves and the environment. The activities included research, verification, demonstration, and training involving six member countries. Improved culture techniques were documented and have been developed into technology packages for dissemination to interested stakeholders in the region.

The following InfoTips were gleaned from the results of the various activities of the Mangrove-Friendly Shrimp Culture Project.



Head Reservoir



Tail Reservoir



Filter Box



Long-arm Paddlewheel



Corner Sludge Collector



Substrates

Mangroves or Aquaculture? Why not both?

Regulate the cutting of mangroves for aquaculture! Mangroves and aquaculture can exist with each other. In fact, aquaculture can be done in mangrove areas. Mangroves showed higher growth rates in the presence of aquaculture effluents than those with no adjacent aquaculture activities. Mangroves can also remove significant levels of nitrogen and solid wastes from shrimp pond effluents.

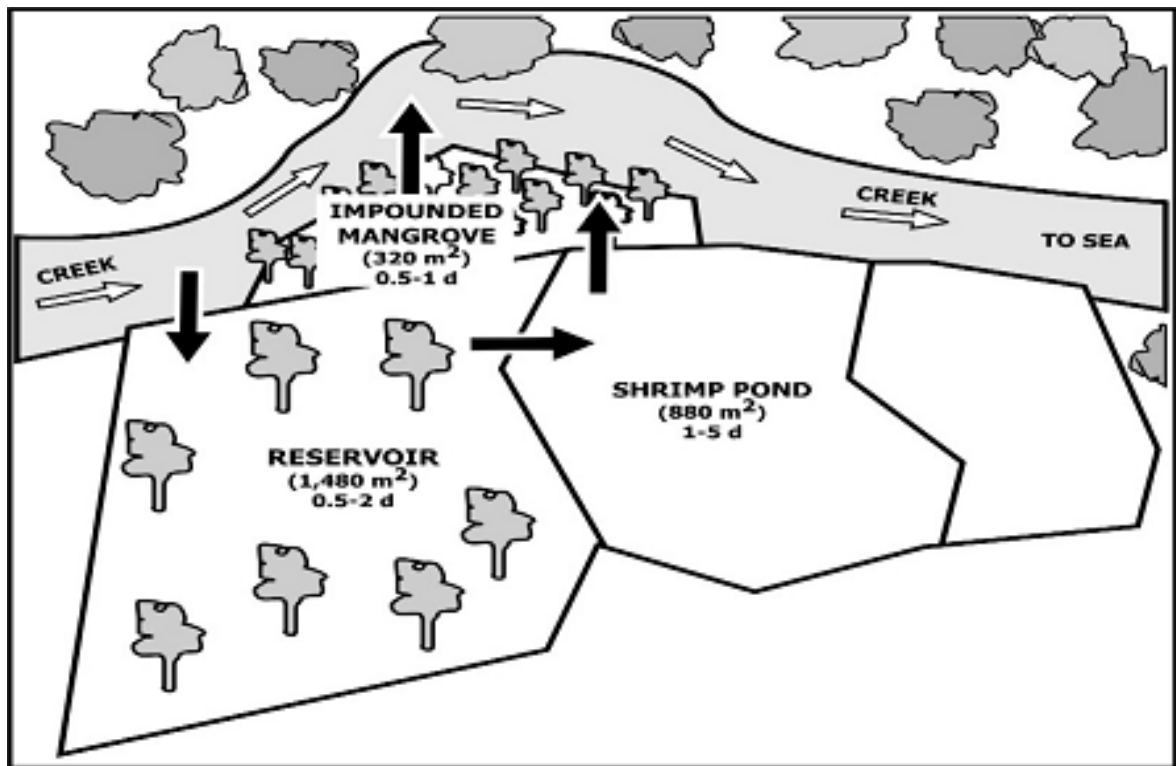
What to do

- Maintain mangroves at an estimated 1.4–1.6 ha to process wastes from one hectare of intensive or semi-intensive shrimp pond. These estimates cover only the waste assimilation function and are therefore minimum levels. Do not use antibiotics and other chemical or biological inputs that may be harmful to mangrove organisms.
- Hold shrimp pond effluents for 6h or more in the mangrove wetland to reduce levels of nitrogen and solid wastes before discharge into the creek
- Harvest mangroves partially (as branches of *Avicennia*, *Sonneratia* and other non-*Rhizophoraceae*) or as the whole tree (for *Rhizophora*, *Ceriops* and other *Rhizophoraceae*) with replanting of the latter. For ponds that border a waterway (creek, river or shore), the mangrove treatment area can also serve as the 20-m to 50-m greenbelt required by law.

Waste water from shrimp farms observing good management practices have no negative effect on natural mangrove areas.

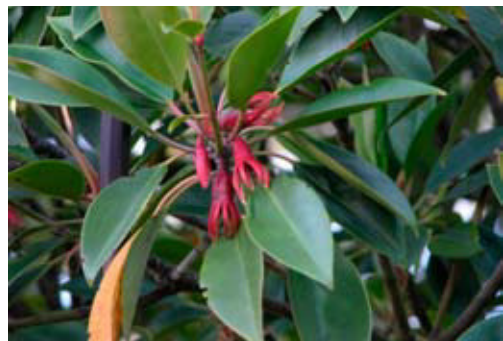


PHOTO BY RIA-I, VIETNAM



Bruguiera gymnorhiza has the highest efficiency on water treatment

Avicennia alba has the highest efficiency on the treatment of high nutrient waste



PHOTOS BY JOHN ALTAMARINO

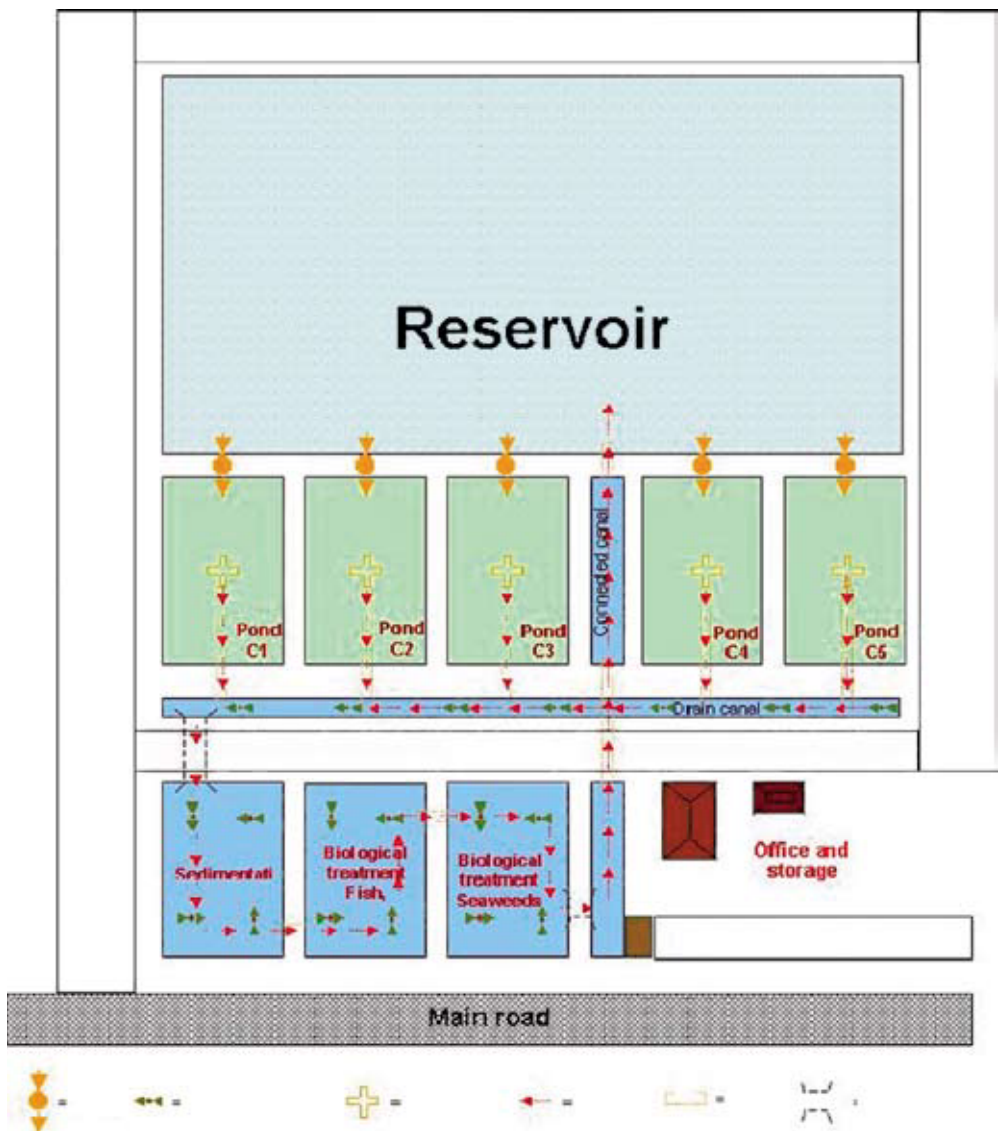
Sources:

Primavera, JH. 2004. Capacity of mangroves to process shrimp pond effluents. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

Sangrungruang, C. 2004. Evaluation of seawater irrigation for intensive marine shrimp farming. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

Good management practices

Conceptual illustration of environment-friendly shrimp farm using the integrated physical and biological technology as effluent treatment system with treated water recirculated through the reservoir.

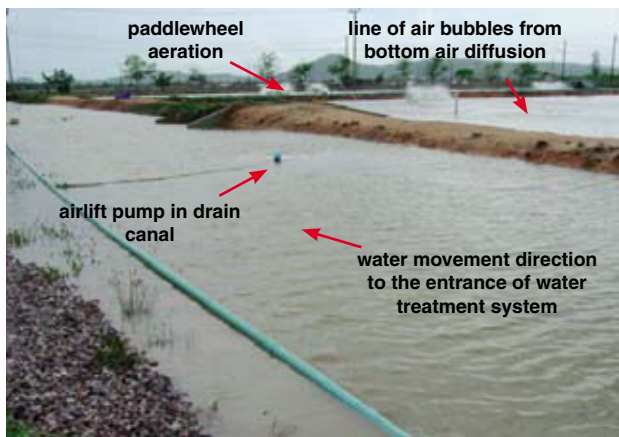


SOURCE: DOF THAILAND

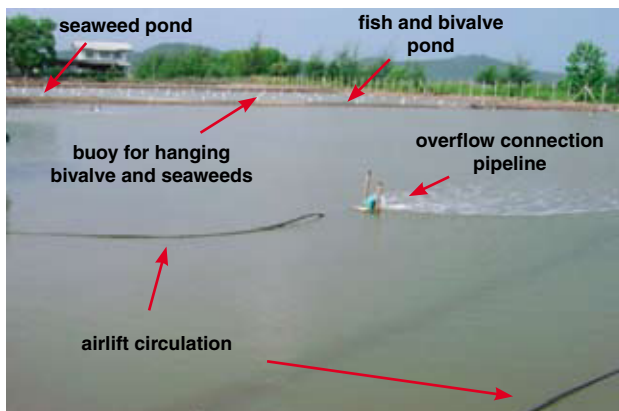
The Manual on Best Management Practices in Shrimp Farming developed by the Department of Fisheries of Thailand features different good management practices. Some more tips are found on the following pages.



The environment friendly shrimp farm



The pond aeration system and circulation system in drain canal



Sedimentation pond

Reference: Songsangjinda, P. 2004. Integrated physical and biological technologies for water recycling in shrimp ponds. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department. February 2004.

Simple biological treatments to reduce luminous bacteria

Using biological treatments can reduce luminous bacteria levels from 7.5×10^2 cfu/ml in the water and 1.0×10^1 cfu/g in the sediments, to zero. Total N and P concentrations in the culture water can also decrease from 33% to 9%.

What are these biological treatments?



Seaweeds



Tilapia



Oysters

How do you do it?



- plant oysters in bamboo platform right at the mouth of shrimp effluent discharge pipes



- stock 15 pc fish and 15 pc oysters/m² to “clean” and maintain good pond water-soil quality for shrimp stocked at 30/m².

Any more tips?

- Integrate algae, fish and settling pond for an effective biological process for the treatment of shrimp farm effluents.
- Replenish pond water lost by evaporation especially during summer months at least once a month.
- During wet seasons, drain excess rainwater to avoid sudden drop of water salinity to as low as 10 ppt.

Source: Golez, Nelson. 2003. Nutrient Cycles: Nutrient Dynamics in Culture Ponds. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

Integrating physical and biological technologies in treating effluents from shrimp farms

This system consists of a grow-out pond (35 x 90 m²) and a treatment pond (30 x 27 m²). A third pond is required to serve as reservoir for new water during the initial filling and to compensate losses due to evaporation and seepage.

The grow-out pond and the treatment pond are connected in order to allow the water to circulate from one pond to the other.

A 0.7-ton capacity filter box is installed in the treatment pond. The filter box is perforated at the sides and bottom and filled with bags containing sand, shells or pieces of broken coral. The inlet of the water supply pump is set in the middle of the bags of filter media. During the operation, the treated water is pumped through the filter tray into the grow-out pond when refilling of water is required. The treatment pond should be efficient so that sediment reduction and water quality improvement should be at least 20-50% better than that of an untreated pond.



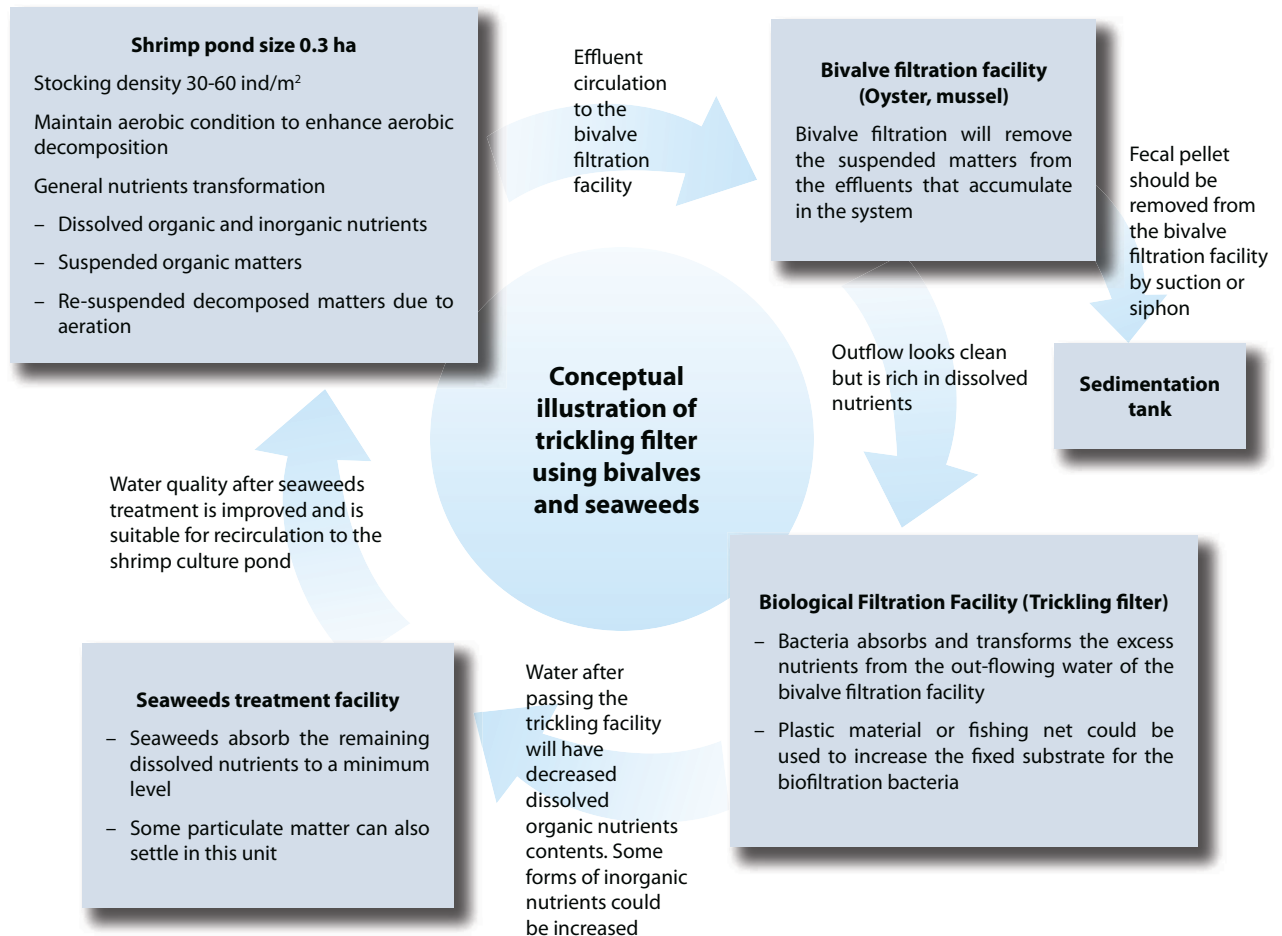
The recirculation shrimp culture system using integrated physical and biological technology

Biological filters like bivalves improve the water quality of pond effluents by removing suspended matter especially particulate organic matter. However, fecal pellets produced by bivalves accumulate and decompose on the pond bottom. Seaweeds on the other hand absorb excess nutrients in the water produced by decomposition.

Source: Songsangjinda, P. 2004. Integrated physical and biological technologies for water recycling in shrimp ponds. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

How then can we treat water effectively?

Integrate trickling filter with biological filter. Trickling filter when integrated with a biological filter has the advantage to remove organic wastes and dissolved nutrients in the water.



Source:

Songsangjinda, P. 2004. Integrated physical and biological technologies for water recycling in shrimp ponds. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

Minimizing obstacles in shrimp farming – The seawater irrigation system...

This system has been tried in Kung Krabaen Bay in Thailand but is yet to be tried in other areas in the region.

What's this system for?

The seawater irrigation system aims to clean up shrimp pond effluents and provide quality water for shrimp culture. This system also serves as a rest canal for rearing water released from the shrimp ponds, by undergoing water treatment before being further released into the bay.

How is this done?

SEAWATER CONDUIT

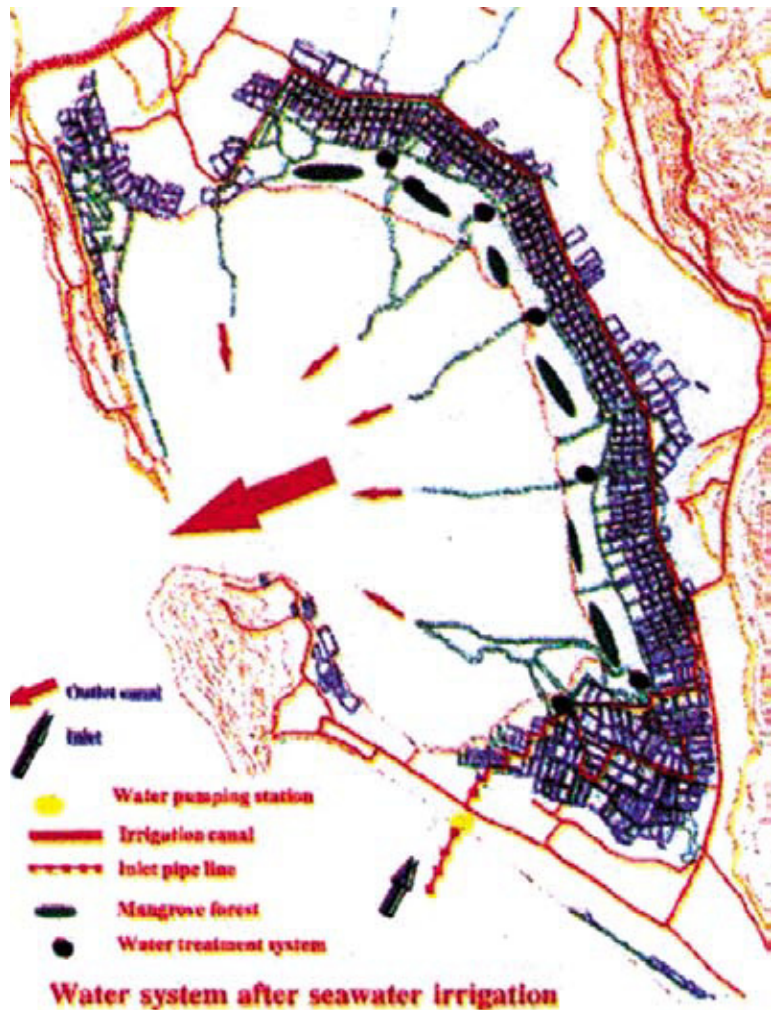
The facility has six rows of high-pressure high density polyethylene (HDPE) conduits, each having a diameter of 1.0m, and buried under the sea at a distance of about 350m offshore. These conduits deliver seawater to the pumping station onshore.

WATER PUMPING STATION

This is a reinforced concrete structure used to pump seawater from the underground storage located about 11.50m deep. This station can store water up to 4650m³ and can continuously drain water using eight 200-HP pumps, each having a drainage capacity of 1.25m³ of water/sec. Water flows in through two 1.0-m diameter HPDE conduits, into a stocking pond which can hold water up to 3000m³.

WATER INLET CANAL

Running a distance of about 8820m, the water inlet canal delivers seawater to the shrimp culture areas. This concrete canal stores seawater from the stocking pond, before the water is finally released into the shrimp ponds by gravity.





SUB-DISTRIBUTORY CANAL (R ROUTE)

5 m wide and approximately 580 m long, the sub-distributory canal is used to receive and distribute seawater to farmers in the lower areas.

SECONDARY CANALS

Separated from the main canal, secondary canals are necessary for delivering water to shrimp ponds since the shrimp culture area is rather large.



Wastewater system

A wastewater system is needed to treat discharged water. This consists of:

- The sludge-pond where suspended solids settle so that clear water flows into the water treatment canal
- The water treatment canals are supplemented with physical and biological treatment systems, with an aeration system consisting of 24 units 5-HP mechanical aerators along the canals. Oysters are hung in the treatment canals to enhance the efficiency of the wastewater treatment before passing the water to the sedimentation canals.
- Sedimentation canals comprise seven local canals, where both sides of the canals lay along the mangrove forest areas. The canals receive discharged water from the treatment canals.

SIS – ensures good water quality for shrimp farming and responsible release of pond effluents.

The effluents from shrimp ponds using SIS do not have adverse effect on the receiving waters and the mangroves in the bay.

Sources:

Sangrungruang Chanin. 2004. Verification and refinement of intensive shrimp culture techniques in Thailand; Evaluation of SIS for intensive marine farming. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.

Ekmaharaj (Tookwinas), Siri. 2002. Seawater Irrigation System for Intensive Shrimp Farming in Thailand. SEAFDEC Asian Aquaculture, Jan-March 2002.

Better ROI? Try this one...

The low discharge and recirculating shrimp culture technologies that have been verified in the different sites under different climatic conditions are capable of achieving high productivity and return on investment (ROI).

What's the ideal stocking density?

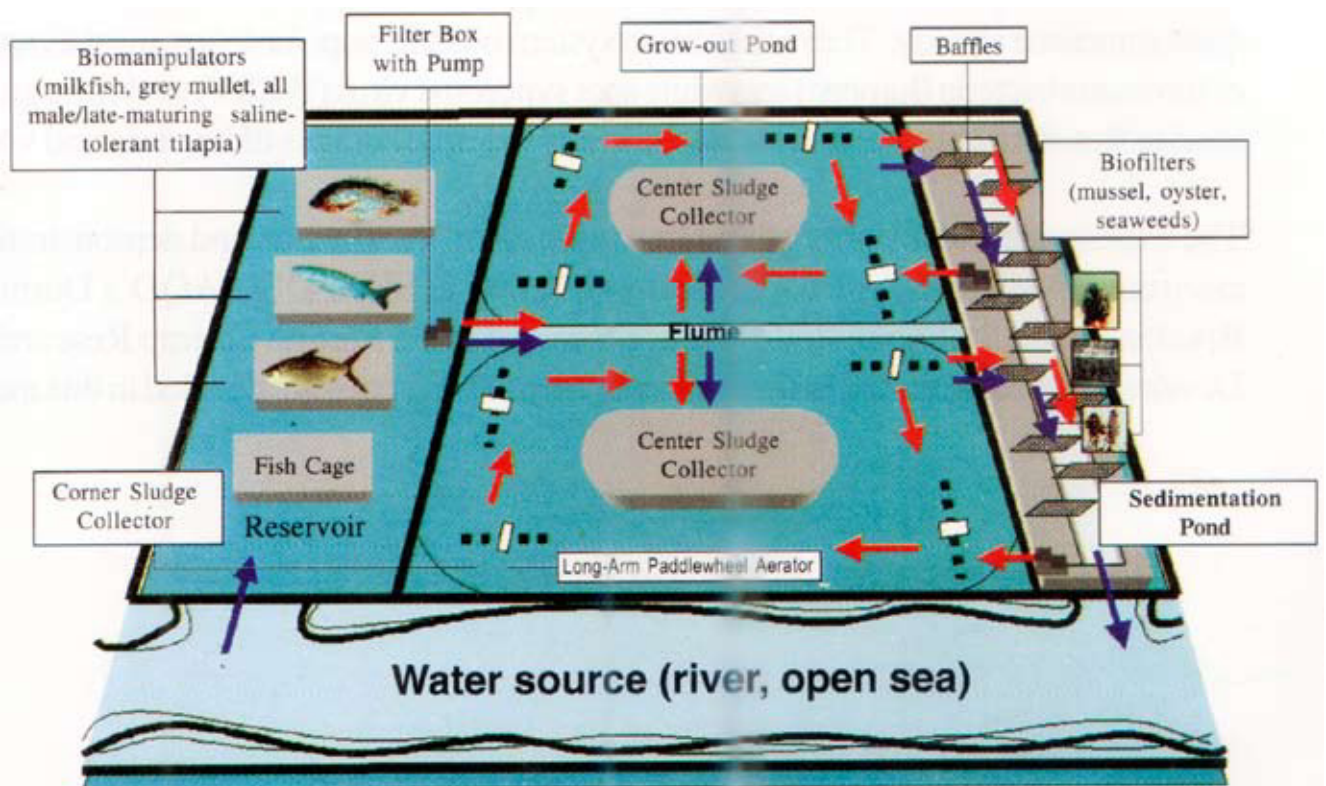
The average net profit/hectare was recorded to be highest with stocking densities around 25 pc/m². The net profit/hectare for 25 pc/m² was P1.8 M while for 15 pc/m² was P1.1 M. In 40 pc/m² stocking density, the average was P0.6 M/ha whereas in 5 pc/m², it was P0.57 M/ha. The high net profit was attributed to the high quality and

uniform sized shrimps harvested with average survival rate of 95%.

In the low discharge system, a small amount of water is discharged from the grow-out pond and released to the sea after passing through the settling pond. Water is pumped only once, from the head reservoir to the grow-out pond.

In the recirculating system, effluents from the grow-out pond are reused after passing through the treatment pond. Water is fully recirculated by pumping twice, first from the head reservoir to the grow-out pond, and second from the treatment pond to the grow-out pond.

Pond layout of a low-discharge/recirculating shrimp farm in AQD's Dumangas Brackishwater Station. Blue arrows indicate low-discharge system. Red arrows indicate closed-recirculation system.



Source: Baliao, Dan D. 2003. Verification and refinement of shrimp culture techniques: Philippines. In: Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, SEAFDEC Aquaculture Department, February 2004.



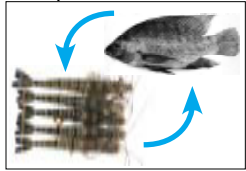

Cost and benefits of environment-friendly shrimp farming


Discharges from shrimp ponds using environment-friendly farming practices do not affect the quality of the receiving waters or mangrove wetlands, hence requires no cost. The average annual investment in pollution management of the shrimp farming industry constitutes a significant portion—around 9% of the annual production cost and only 3-4% of environmental benefits that the environment-friendly shrimp farming practices would generate.

The opportunity cost of not utilizing environment-friendly shrimp farming practices is estimated at PhP740,000/ha in pollution damage to the fisheries and PhP44,000 to human health. Thus, environment-friendly shrimp farming practices generate net economic benefits for the economy as a whole and the Philippine society for they increase the economic value of mangrove habitats in supporting fisheries.

This study was conducted in the Philippines only and values may be different in other countries. Make your own assessment of the following cost and benefits of environment-friendly shrimp farming:

Cost and benefits of environment-friendly shrimp farming

Environment-friendly Practices	Cost to Farmer	Benefits to Farmer	Benefits to Environment
1. Lowering of stocking density 	<ul style="list-style-type: none"> Decrease in harvest volume by around 20-30% 	<ul style="list-style-type: none"> Increased harvest value by 8-10% due to bigger size and improved physical quality Improved feed conversion Reduced risk of opportunistic diseases 	<ul style="list-style-type: none"> Reduced feed use (hence nutrient load) by at least 20%
2. Improvement of pond bottom management 	<ul style="list-style-type: none"> Increase in plowing/tilling cost by P5,000-7,000/ha/yr Cost of P12,000/ha for construction of net cages (to be depreciated in 2 years) and P5,000/ha/yr for tilapia fingerlings (note: cost is recovered from sale of fish) 	<ul style="list-style-type: none"> Improved bacterial profile of sediment and reduced count of pathogenic <i>Vibrio</i>, resulting to healthier shrimps and reduced risk of opportunistic diseases 	<ul style="list-style-type: none"> Improved effluent quality, with lower levels of nutrients (i.e. N and P) and suspended solids
3. Crop rotation 	<ul style="list-style-type: none"> Cost of P25,000-35,000/ha/yr for fish culture inputs (e.g. fry, feeds, etc.) and labor (note: cost is recovered from sale of fish) Loss of 1 shrimp crop per year 	<ul style="list-style-type: none"> Improved bacterial profile of sediment and reduced count of pathogenic <i>Vibrio</i>, resulting to healthier shrimps and reduced risk of opportunistic diseases Significantly reduced risk of white spot syndrome virus (WSSV) disease as virus tends to be active only during cold months 	<ul style="list-style-type: none"> Reduced organic load in receiving waters during period of low density fish culture allowing accumulated organic waste in sediment to break down
4. Improvement in feed quality 	<ul style="list-style-type: none"> Increase in commercial feed cost by P3-4/kg and additional cost of around P2/kg feed for farm level nutritional supplements; equivalent to a P30,000-60,000/ha/crop increase in feed cost 	<ul style="list-style-type: none"> Improved growth, health, and physical quality of stocks Reduced feed use by 10-15% based on improved FCR; partly due also to the enhancement of natural food productivity (i.e. from heterotrophic food web) resulting from use of probiotics and the increase in aeration 	<ul style="list-style-type: none"> Improved effluent quality, with lower levels of nutrients (i.e. N and P) and suspended solids

Environment-friendly Practices	Cost to Farmer	Benefits to Farmer	Benefits to Environment
5. Stocking of laboratory-screened fry 	<ul style="list-style-type: none"> Higher fry cost, from P0.12-0.16/pc to P0.25-0.30/pc, resulting to a higher seed expense of around P40,000/ha/crop Additional fry analysis expenses of P2,000/ha/crop prior to stocking Prolonged waiting time in fry selection, resulting to delays in stocking of up to 3 weeks 	<ul style="list-style-type: none"> Reduced risk of WSSV disease and pathogenic <i>Vibrio</i> infection Improved growth performance and survival of stocks 	<ul style="list-style-type: none"> Minimized risk of spreading diseases to receiving waters
6. Use of "greenwater" technology 	<ul style="list-style-type: none"> Reduction in shrimp grow-out area by 25-50% due to requirement for bigger reservoir Cost of P25,000-35,000/ha/yr in reservoir pond for fish culture inputs (e.g. fry, feeds, etc.) and labor (note: cost is recovered from sale of fish) Modification of water supply channel and addition of transfer pump at a cost of P5,000-10,000/ha (to be depreciated in 3 years) 	<ul style="list-style-type: none"> More stable water quality which reduces stress to cultured animals Suppressed growth of pathogenic bacteria, particularly <i>Vibrio harveyi</i> sp., minimizing risk of disease and premature harvest 	<ul style="list-style-type: none"> Reduced water use and effluent volume Reduced load of pathogenic <i>Vibrio</i> in effluent water
7. Use of probiotics in water and feed 	<ul style="list-style-type: none"> Total cost of P20,000-40,000/ha/crop, depending on type of probiotics and dosage 	<ul style="list-style-type: none"> Production of healthy antibiotic-free shrimp Suppressed growth of pathogenic bacteria, particularly <i>Vibrio harveyi</i> sp., minimizing risk of disease and premature harvest Improved water quality and lower sludge accumulation, reducing stress and risk of opportunistic diseases Reduced need for water exchange (i.e. lower pumping cost) 	<ul style="list-style-type: none"> Reduced risk of developing more virulent antibiotic-resistant strains of bacteria Improved effluent quality, with lower levels of nutrients (i.e. N and P) and suspended solids Reduced load of pathogenic <i>Vibrio</i> in effluent water
8. Increase in aeration 	<ul style="list-style-type: none"> Additional fixed cost for aerators and electrical distribution/generation system amounting to P150,000-200,000/ha (to be depreciated in 3 years) Increase in power consumption by 50-60% 	<ul style="list-style-type: none"> Faster growth, improved feed conversion, better physical quality, and reduced risk of opportunistic diseases Reduced need for water exchange (i.e. lower pumping cost) More stable plankton (i.e. less plankton crash) and hence lesser water exchange 	<ul style="list-style-type: none"> Increased DO level in effluent (from 4 ppm to 5 ppm) and reduced level of noxious metabolites, especially ammonia and hydrogen sulfide Reduced water exchange and effluent volume
9. Use of settling pond 	<ul style="list-style-type: none"> Additional cost of around P2,500-5,000/ha/yr for construction and maintenance of net baffles and bamboo support, and removal of accumulated waste 	<ul style="list-style-type: none"> Improved water quality in receiving waters 	<ul style="list-style-type: none"> Lower load of suspended solids in effluent water Reduced accumulation of sediment in receiving waters
10. Employment of biosecurity measures 	<ul style="list-style-type: none"> Additional cost of P15,000-20,000/ha/yr for pond sanitation, carrier exclusion devices, filters, and worker hygiene 	<ul style="list-style-type: none"> Significantly reduced risk of introducing viral diseases, particularly WSSV 	<ul style="list-style-type: none"> Reduced water usage and effluent volume by 60-70% Minimized risk of spreading diseases in receiving waters

Reference: Samonte-Tan, G. and P. Cruz. 2006. Economic valuation of environment-friendly shrimp farming in mangrove areas (a study funded by the Mangrove-Friendly Shrimp Culture Project).



The Mangrove-Friendly Shrimp Culture Project was made possible through the financial and technical support of the:

Fisheries Agency of the Government of Japan
ASEAN-SEAFDEC Fisheries Consultative Group
SEAFDEC Secretariat, and
Department of Fisheries of the Government of Thailand
as the Project's Lead Country for the ASEAN





The ASEAN-SEAFDEC Fisheries Consultative Group (FCG) was organized by ASEAN and SEAFDEC In March 1999 to (a) Identify important regional and international fisheries issues; (2) provide technical assistance and inputs to ASEAN for the formulation and implementation of common policies; (3) assist the Member Countries in formulating common stand and positions on regional and international fishery issues; and (4) develop and implement collaborative programs. The FCG comprises the Chairman and representatives of the ASEAN Working Group of Fisheries (WGFi), the SEAFDEC Secretary-General and his representatives, and the SEAFDEC Department Chiefs with the WGFi Chairman and SEAFDEC Secretary-General as Co-Chairpersons.

Included in the first four projects implemented through the FCG collaborative mechanism, is the Promotion of Mangrove-Friendly Aquaculture in Southeast Asian Countries with SEAFDEC/AQD as the Lead Department for SEAFDEC and Thailand as the Lead Country for the ASEAN.



SEAFDEC Member Countries are also
Member Countries of the ASEAN except Japan